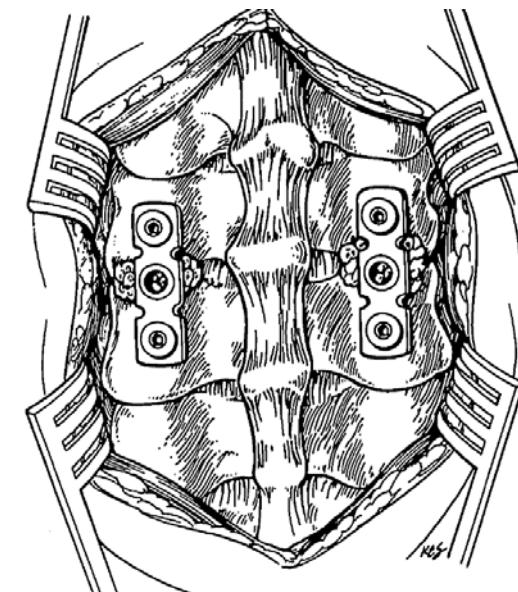
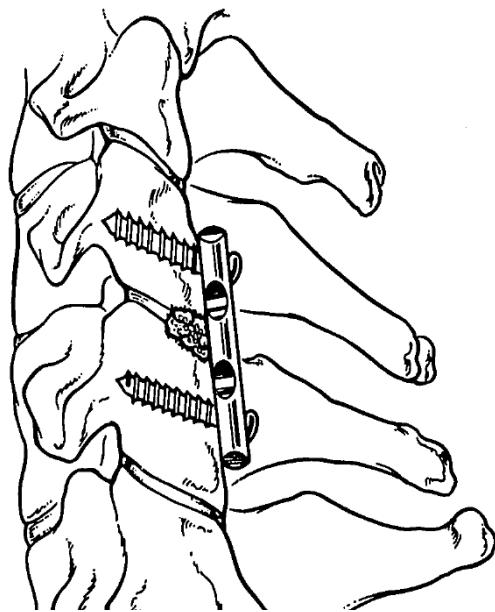
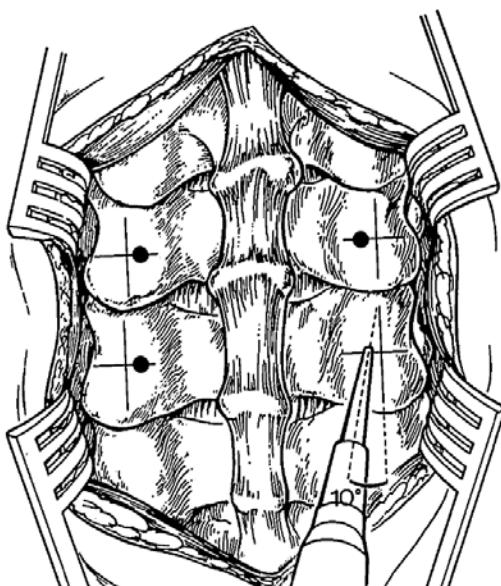


# Lateral Mass and Pedicle Screws

## Fixation of Cervical Spine



Paul A Anderson  
University of Wisconsin  
AAOS Biomedical Engineering Committee  
Co-chair ASTM F05-24

Anderson Spine 1991

# Purpose

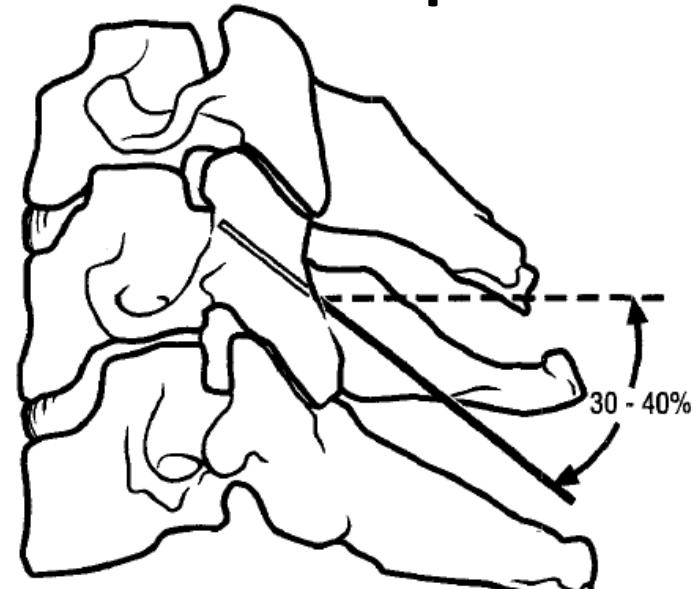
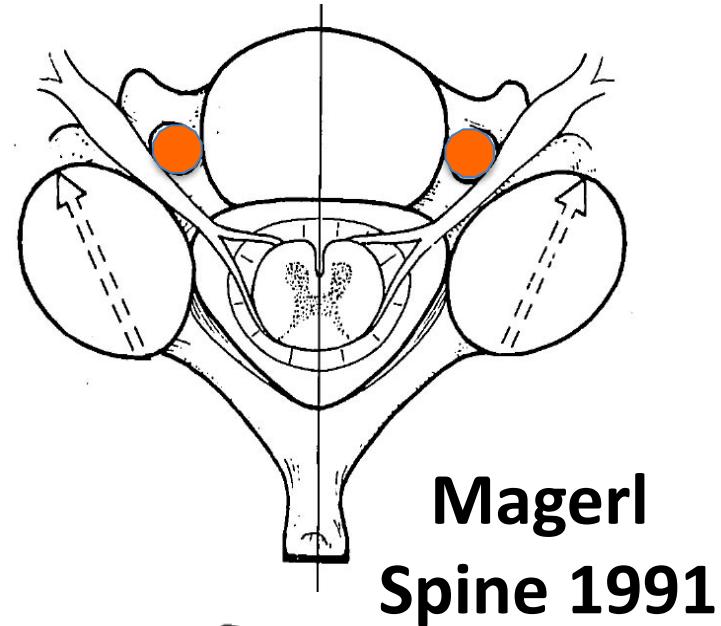
- Anatomy
- Surgical indications
- Efficacy
- Safety
- AAOS recommendations

# Indications

- Trauma
  - Unstable fracture
- Reconstruction
  - Tumor, osteomyelitis
  - Inflammatory ds eg rheumatoid arthritis
- Degenerative conditions
  - Combined posterior decompression
  - Adjunct multilevel fixation
- Pediatric spine
  - Congenital malformations

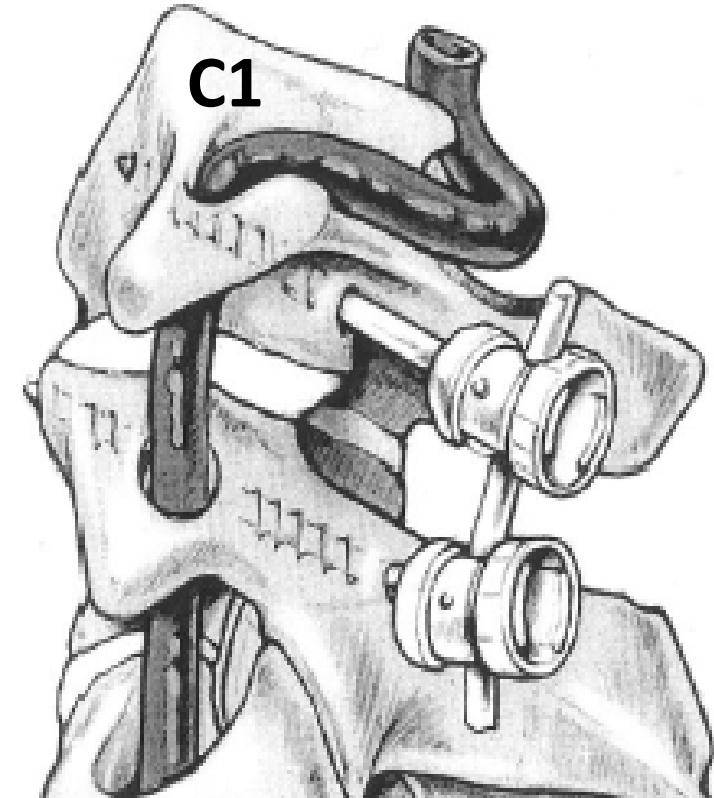
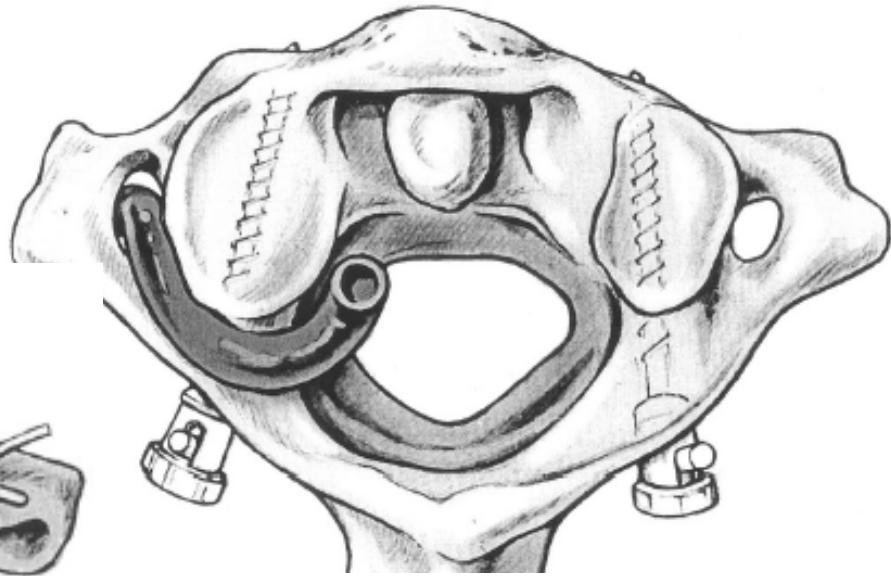
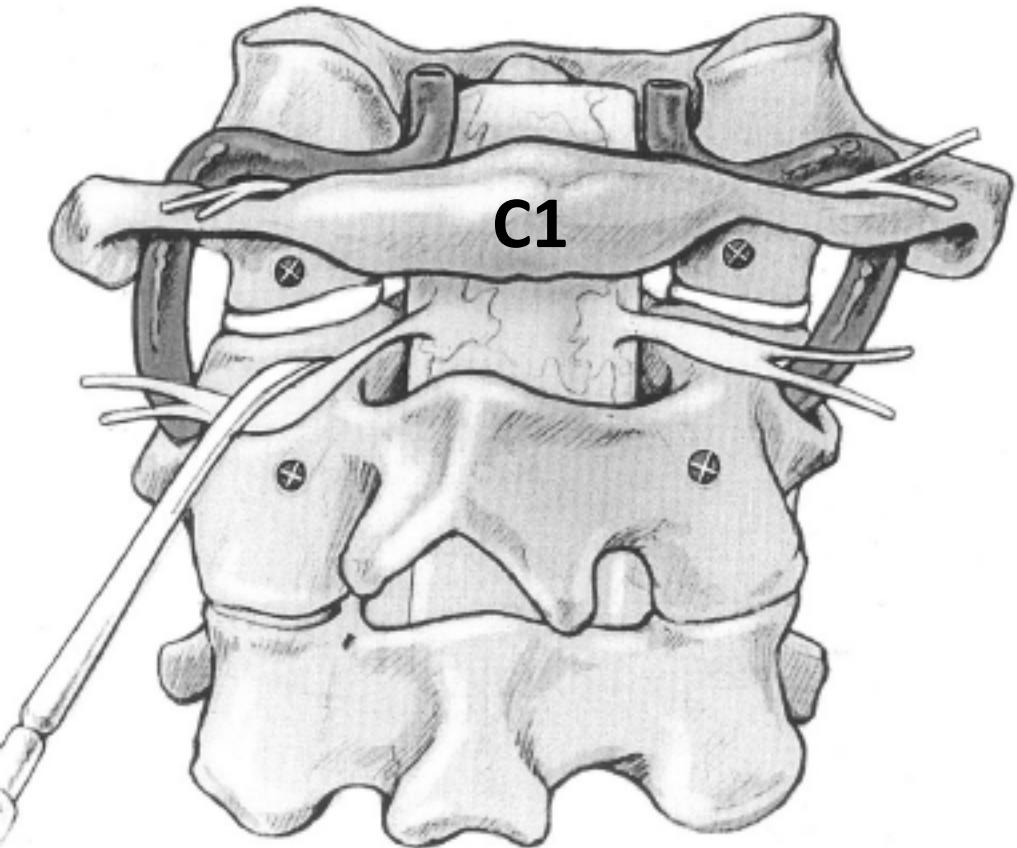
# Anatomy Lateral Mass

- Vertebral artery
  - Lies anterior valley
  - Deep
  - Avoided
    - Proper starting point
    - up and out direction



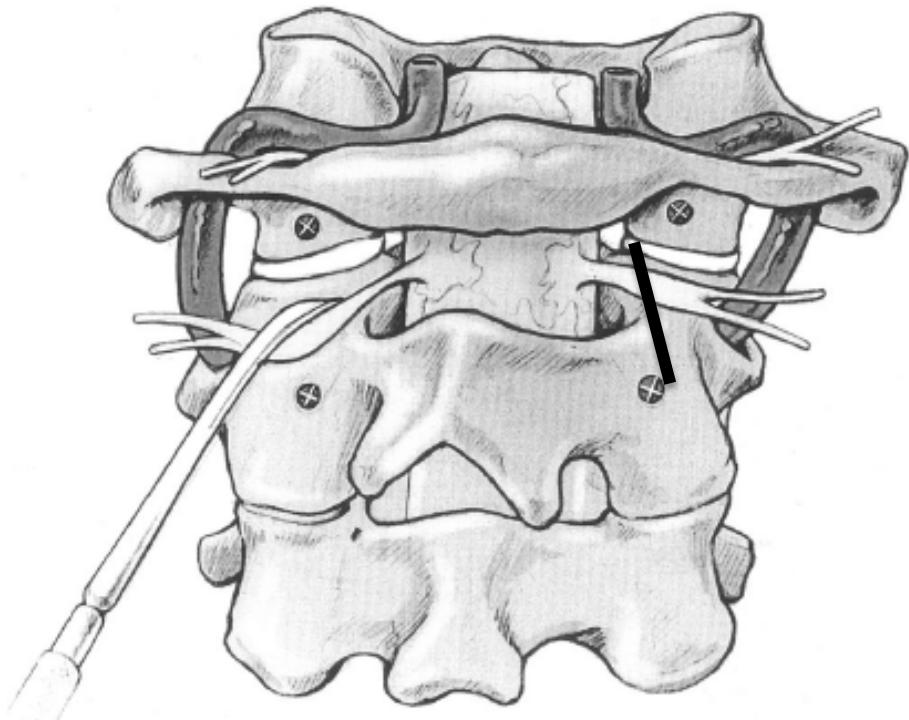
Anderson Spine 1991

# C1 Anatomy

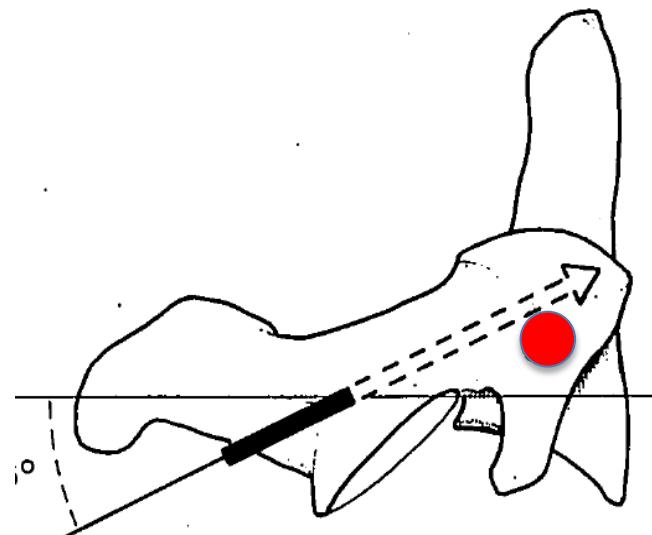
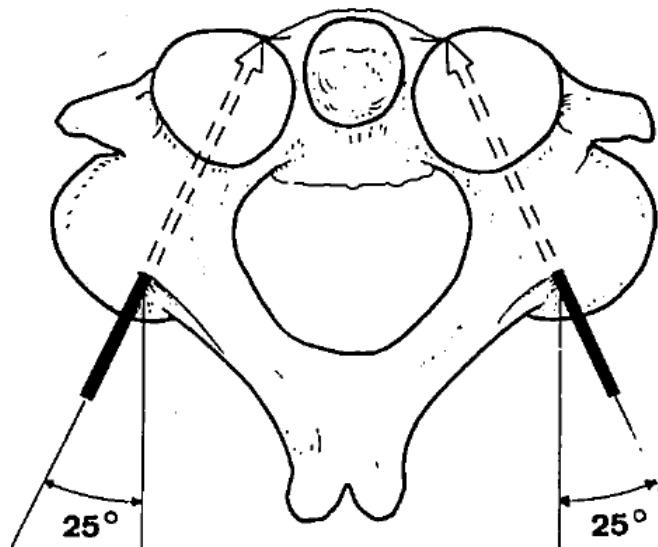


Harms Spine 1994

# C2 Pedicle

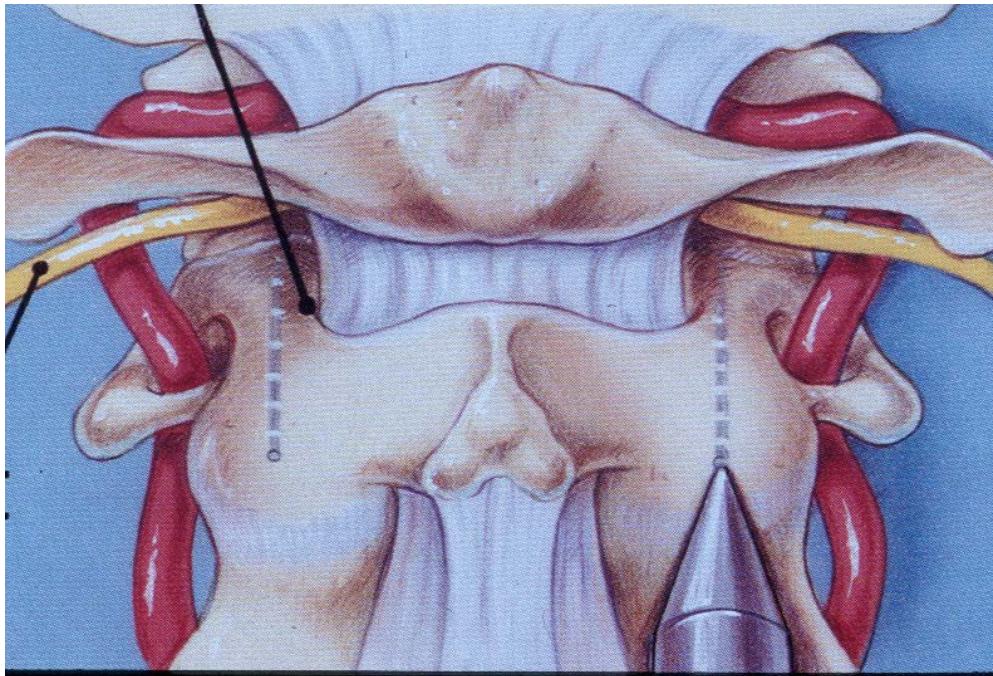


Harms Spine 1994

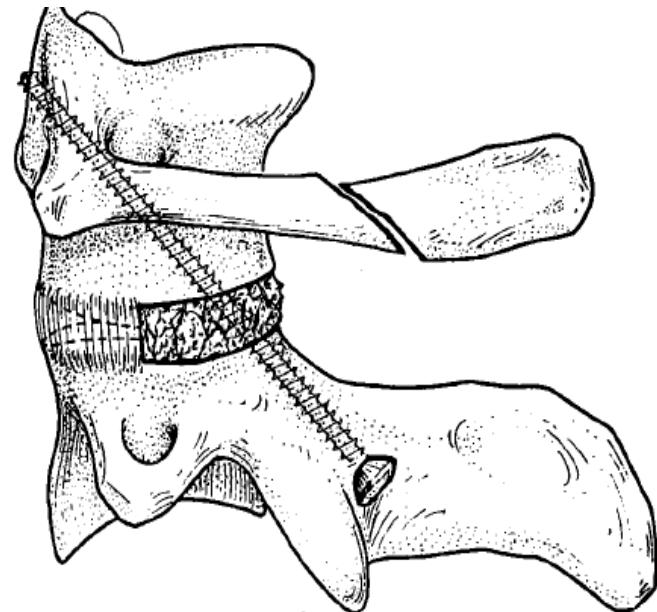


Magerl Spine 1991

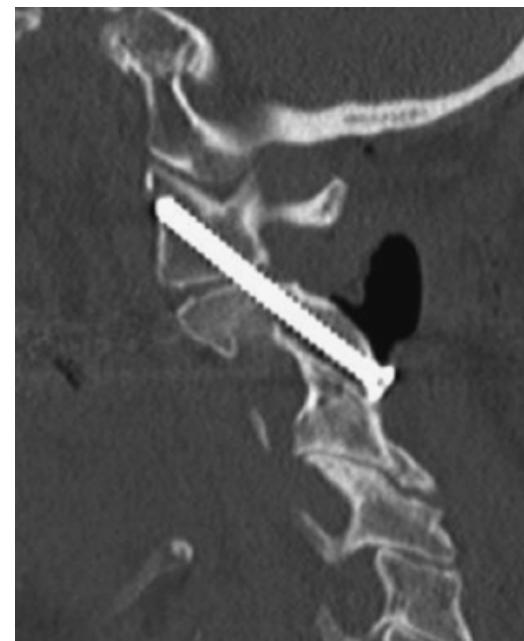
# C2-C1 Transarticular Screw



Finn Neurosurg 2010



Magrel JsDS 1992



Bransford JAAOS 2010

# C2 Laminar Screws

- Intralaminar screws
- Avoid vertebral artery
- Short 20-25 mm
- Limit decortication for fusion



**Bransford JAAOS 2011**

# Efficacy

- Fusion success
- Construct success

	Patients	Follow-up (mo)		
Ebraheim	J OrthoTrauma	1989		
Anderson	Spine	1991		
Jeanneret	Spine	1991		
Nazarian	Spine	1991		
Levine	Spine	1992		
Roy-Camille	Spine	1992		
Fehlings	JNS	1994		
Ebraheim	JSpDs	1995		
Heller	Spine	1995		
Wellman	Spine	1998		
Horgan	JNS Focus	2002		
Deen	Spine Journal	2003		
Sekhon	JSpDs	2005		
Wu	Surg Neuro	2008		
Katonis	JSpDs	2011		
Liu	JSpDs	2012		

	Patients	Follow-up (mo)	Fusion (%)	Construct Failures
Ebraheim	J OrthoTrauma	1989	100	
Anderson	Spine	1991	100	
Jeanneret	Spine	1991	100	
Nazarian	Spine	1991	100	
Levine	Spine	1992	100	
Roy-Camille	Spine	1992	?	
Fehlings	JNS	1994	93	
Ebraheim	JSpDs	1995	100	
Heller	Spine	1995	98	
Wellman	Spine	1998	97%	
Horgan	JNS Focus	2002	100	
Deen	Spine Journal	2003	-	
Sekhon	JSpDs	2005	-	
Wu	Surg Neuro	2008	-	
Katonis	JSpDs	2011	97.5	
Liu	JSpDs	2012	100	

	Patients	Follow-up (mo)	Fusion (%)	Construct Failures
Ebraheim	J OrthoTrauma	1989	100	0
Anderson	Spine	1991	100	3 Inc kyphosis
Jeanneret	Spine	1991	100	0
Nazarian	Spine	1991	100	-
Levine	Spine	1992	100	6 Inc kyphosis
Roy-Camille	Spine	1992	?	15 (6.7%) Inc kyphosis
Fehlings	JNS	1994	93	3 Failures
Ebraheim	JSpDs	1995	100	1
Heller	Spine	1995	98	6 hardware,inc kyphosis
Wellman	Spine	1998	97%	1 Hardware failure
Horgan	JNS Focus	2002	100	0
Deen	Spine Journal	2003	-	0
Sekhon	JSpDs	2005	-	3
Wu	Surg Neuro	2008	-	1 Inc kyphosis
Katonis	JSpDs	2011	97.5	3 Screw pullout
Liu	JSpDs	2012	100	0

	Patients	Follow-up (mo)	Fusion (%)	Construct Failures
Ebraheim	J OrthoTrauma	1989	100	0
Anderson	Spine	1991	100	3 Inc kyphosis
Jeannere				
Nazarian				
Levine				
Roy-Cam				
Fehlings				
Ebraheim				
Heller				
Wellman				
Horgan				
Deen	Spine Journal	2003	-	0
Sekhon	JSpDs	2005	-	3
Wu	Surg Neuro	2008	-	1 Inc kyphosis
Katonis	JSpDs	2011	97.5	3 Screw pullout
Liu	JSpDs	2012	100	0

High fusion success

Mostly plates, few rod-screw

0-10% Increased kyphosis

Rare hardware failure

# Safety

- Nerve root injury
- Vertebral artery injury

	Patients	Follow-up (mo)	Root Injury	Vertebral Artery Injury
Ebraheim	13	13.1	0	
Anderson	30	17.8	0	
Jeanneret	51	12-54	0*	
Nazarian	23	12-24	0	
Roy-Camille	221	?	?	*Cord injury asc reduction/ decompression
Levine	24	19	6 (25%)	
Fehlings	44	46	0	
Ebraheim	36	17	0*	
Heller	78	24	7 (9%)	
Wellman	43	25	0	
Horgan	9	9	0	
Katonis	225	18	5 (2.2%)	
Deen	21	12	3 (14.3%)	
Sekhon	115	-	1 (0.7%)*	
Wu	115	-	0	
Liu	37	28	0	

	Patients	Follow-up (mo)	Root Injury	Vertebral Artery Injury
Ebraheim	13	13.1	0	0
Anderson	30	17.8	0	0
Jeanneret	51	12-54	0*	0
Nazarian	23	12-24	0	0
Roy-Camille	221	?	?	?
Levine	24	19	6 (25%)	0
Fehlings	44	46	0	0
Ebraheim	36	17	0*	0
Heller	78	24	7 (9%)	0
Wellman	43	25	0	0
Horgan	9	9	0	0
Katonis	225	18	5 (2.2%)	0
Deen	21	12	3 (14.3%)	0
Sekhon	115	-	1 (0.7%)*	0
Wu	115	-	0	0
Liu	37	28	0	0

	Patients	Follow-up (mo)	Root Injury	Vertebral Artery Injury
Ebraheim	13	13.1	0	0
Anderson	30	17.8	0	0
Jeanneret	51	12-54	0*	0
Nazarian	Safety			
Roy-Camille	Root at small risk 1.2%			
Levine	Vertebral artery – none			
Fehlings				
Ebraheim				
Heller				
Wellman	43	25	0	0
Horgan	9	9	0	0
Katonis	225	18	5 (2.2%)	0
Deen	21	12	3 (14.3%)	0
Sekhon	115	-	1 (0.7%)*	0
Wu	115	-	0	0
Liu	37	28	0	0

# Summary Clinical Data

## C3-7 Lateral Masses

- Poor study design
- High efficacy >97% healing
- Maintenance of stability good >95% of cases
- Complications:
  - Vertebral artery injury rare
  - Root injury 0-5%
  - Hardware failure rare except screw back out in plates

# Current Classification Limitations

- Confusing: standard of care but used off label
  - Medicolegal risks
- Prevent teaching of technique
  - Hands on courses (industry and organizations)
- Research not supported by industry
  - Avoid perception off label marketing

# AAOS Recommendations

- Lateral mass fixation is widely used > 20 years
- ASTM standards adequate mechanical testing
- Support classification to Class 2 for:
  - Lateral mass screws C1 and C3-7
  - Pedicle screws C2, C7
- Do not support labeling for C3-6 pedicle screws
- AAOS looks forward to working with FDA to improve patient safety

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